thing doing.' All calamity-howlers to the contrary notwithstanding, the canal is as sure to be built as a natural law is certain of fulfilment; and those who to-day busy themselves trying to find arguments against it are going to be ashamed and sorry when the seas are eventually linked by the greatest engineering undertaking in the history of mankind. For a canal which saves nine thousand miles of ocean journey between San Francisco and New Orleans, six thousand miles between Yokohama and New Orleans, two thousand miles between Hong Kong and New Orleans and six thousand miles between Sydney and New Orleans, is an agency in bringing mankind nearer to mankind too vastly important to evade the sight of God and escape the desire of nations. But just now, rather than any statement of cubic yards excavated in August or September or October, one finds the following figures significant:

In June, 1905, there were 62 cases of yellow fever on the isthmus; in July, 42; in August, 27; in September, 6; in October, 3. In August, 1905, with a force of 12,000 men at work, the death-rate was two thirds of one per 1,000, whereas under the French régime, in August, 1882, with a force of 1,900 men, the death-rate was no less than 112 per thousand. These figures will appeal to the citizens of a community whose recent fight against yellow fever has been the admiration of the civilized world and a great object-lesson to uncivilized humanity; an object-lesson in civic self-dependence, public spirit and uncommemorated heroism. A city that can pass through such an ordeal, a city that faces a great crisis as New Orleans faced the yellow-fever epidemic, is the surest guarantee that the nation of which that city is a part will do her duty by civilization, and build, expeditiously and economically, the Roosevelt Canal.

FULLERTON L. WALDO.

THE MOVEMENT IN PRUSSIA FOR THE REORGANIZATION OF THE INSTRUCTION IN MATHEMATICS AND THE NATURAL SCIENCES IN THE SECONDARY SCHOOLS.

FOR over a decade, there has been a noteworthy movement in Prussia aiming at the improvement of instruction in mathematics in the secondary schools.[1] The aim is not an increase of the amount of time given to mathematics, but a reorganization of the subject matter of the mathematical curriculum so as to bring it into closer conformity to the needs of the times, in particular by giving more attention to the applications of mathematics, and by laying less stress in the earlier years on those more abstract phases of the subject which overtax the pupils' powers at that time. The most prominent leader in the movement is Professor Klein, of Göttingen, whose views are most readily accessible to American readers in a recent book collecting various addresses and papers of his on the teaching of mathematics.[2] He is a pronounced advocate of the introduction of the elements of the differential and the integral calculus into the work in mathematics in the secondary schools of Prussia.

This agitation has borne fruit in the new Prussian curricula of 1901, wherein decidedly more stress than previously is laid on concrete beginnings, on graphic methods, on deferring the more abstract phases of the various subjects and on applications throughout to the affairs of practical life

[1] This term is used as indicating the closest American equivalent. The German term is 'higher schools.' Pupils are admitted to the schools at the age of nine, the course of instruction covers nine years, and the normal age of graduation is nineteen or twenty. In mathematics the ground covered is approximately that of our grades, secondary schools and freshman year in college.

[2] F. Klein, 'Uber eine zeitgemässe Umgestaltung des mathematischen Unterrichts an den höheren Schulen,' Leipzig, 1904, pp. ii + 82.

and to the physical sciences. The elements of the calculus were, however, not introduced, even optionally, nor was there an increase in the small amount of analytic geometry to be given in the last year of the course; on the contrary, the option was introduced of proving synthetically instead of analytically such properties of the conic sections as might be taken up. In the curricula of 1901, the ground to be covered in the last two years is stated without specifying the portion to be taken up in each of the years. This would seem to leave it to the discretion of the teacher to determine at what point in the last two years the idea of coordinates should be taken up, but a remark in the general instructions seems to indicate that it is expected that it be taken up in the last year of the course, as formerly.

While questions relative to the teaching of mathematics were thus being vigorously agitated, a no less vigorous agitation was taking place relative to the teaching of the natural sciences. During the last decade the large and influential Association of German Natural Scientists and Physicians has given extended consideration to these questions. At the annual session held in Hamburg in 1901, a joint meeting of the sections for botany, zoology, mineralogy and geology, and anatomy and physiology, over one hundred members present, unanimously adopted a set of nine propositions relative to instruction in biology. These nine propositions soon became generally known as the 'Hamburg Theses,' and read as follows:

1. Biology is an experiential science which indeed goes as far as well-grounded knowledge of nature will at the time allow, but no further. (*Die Biologie ist eine Erfahrungswissenschaft die zwar bis zur jeweiligen Grenze des sicheren Naturerkennens geht, aber dieselbe nicht überschreitet.*) For metaphysical speculations, biology as such has no responsibility and the school no use.

2. *Formally,* instruction in the natural sciences is the necessary complement of the abstract subjects. In particular, biology teaches the art, elsewhere so neglected, of observation of concrete objects subject to continual change in consequence of the processes of life, and, like physics and chemistry, proceeds inductively from observation of properties and processes, to the logical formation of concepts.

3. *As to content,* instruction in natural history has the duty of acquainting the growing youth with the most essential forms of the organic world, to discuss the manifold phenomena of life, to present the relations of organisms to inorganic nature, to each other and to man, and to give a survey of the most important periods of the earth's history. Upon the basis of the biologic knowledge acquired, the structure of the human body and the functions of its organs, together with the chief points of general hygiene, deserve special attention.

4. *Ethically,* biologic instruction awakens respect for the structures of the organic world, an appreciation of the beauty and completeness of nature as a whole, and thus becomes a source of the purest enjoyment, untouched by any of the practical interests of life. At the same time, he who busies himself with the vital phenomena of nature is led to feel the incompleteness of human knowledge, and to recognize his own limitations.

5. Such knowledge of the organic world must be regarded as necessary part of the general culture which the times demand; it is not only useful to the future natural scientist or physician as preparation for his professional study, but is equally important for those graduates of the secondary schools whose future occupation does not directly require study of nature.

The remaining four theses relate more specifically to German conditions, pointing out that under the present curricula biologic study is excluded from the later years of the course, in which years alone the pupil is sufficiently mature to understand what is taught of the processes of life and the influence of environment; demanding that biologic instruction should be given, say two hours weekly, throughout the nine years of the school course; and making some specific proposals whereby it is thought this can be accomplished.

A committee was formed to circulate the theses and the adhesion of about eight hundred scientists was secured. At the session of the association in Cassel in 1903 this committee made a report and proposed that the Hamburg Theses be adopted by the general session of the association. This was done by the adoption of the following motion made by F. Klein, professor of mathematics in the University of Göttingen:

The *Gesellschaft deutscher Naturforscher und Aerzte* unanimously accepts the Hamburg Theses of the committee for the advancement of biologic instruction in the higher schools, with the reservation that the totality of the questions relative to instruction in mathematics and the natural sciences be made the subject of comprehensive discussion at the earliest opportunity.

In consequence of this resolution, the general session of the association at Breslau in 1904, took up the topic, 'Report and Debate on the Instruction in Mathematics and the Natural Sciences in the Higher Schools.'

Preparation was made for the session at Breslau in the discussions of various other societies, such as the *Verein zur Förderung des Unterrichts in der Mathematik und den Naturwissenschaften,* and the *Verein deutscher Ingenieure,* both of which also sent official delegations to the meeting at Breslau.

At this meeting the following reports were presented:

K. FRICKE: 'The Present Situation of Instruction in Mathematics and the Natural Sciences in the Higher Schools.'

F. KLEIN: 'Remarks on Instruction in Mathematics and Physics.'

F. MERKEL: 'Wishes Relative to Instruction in Biology.'

G. LEUBUSCHER: 'Considerations on School Hygiene.'

After discussion of these reports, all the questions involved were referred to a commission constituted as follows:

Messrs. Gutzmer, chairman, representing the section for natural sciences.

Schotten, representing the section of pedagogy.

Leubuscher and Verworn, representing the medical section.

Klein, representing the German Mathematical Association.

Pretzker and Schmid, representing the Society for the Advancement of Instruction in Mathematics and the Natural Sciences.

Poske, representing the German Physical Society.

Fricke and Kraepelin, representing the biological committee.

v. Borries and Duisberg representing the interests of engineers and practical chemists.

The commission has now published a report[3] which is a document of great interest and well worth study beyond the confines of the kingdom with whose educational affairs it primarily concerns itself.

The report consists of four parts: A general report by the chairman, and special reports on instruction in mathematics, in physics and in chemistry (mineralogy), zoology (anthropology), botany and geology.

The commission set up unanimously three governing principles:

I. The commission wishes that instruction in the higher schools be neither one-sidedly linguistico-historical, nor one-sidedly mathematico-scientific.

II. The commission recognizes mathematics and the natural sciences as of equal culture value with the languages and adheres to the principle of specific general culture in the higher schools.

III. The commission declares that the enjoyment in fact of equal rights by the three classes of higher schools is absolutely necessary and wishes its complete realization.

In these three principles the commission

[3] 'Bericht der Unterrichtskommission der Gesellschaft deutscher Naturforscher und Aerzte über ihre bisherige Tätigkeit,' pp. 57, Leipzig, 1905 (F. W. C. Vogel, publisher).

formulated what seems to be the central aim of the entire agitation, to secure recognition, in theory and in fact, of mathematics and the natural sciences as of equal culture value with the linguistic and historical subjects.

It may not be out of place to state in a few words the conditions as they exist in Prussia to-day. It has been stated above that the Prussian secondary or higher schools have a course of nine years to which boys are admitted at the age of nine. This makes the normal age of graduation about nineteen. There are three classes of these institutions, the *Gymnasia,* with Latin and Greek, the *Realgymnasia,* with Latin but no Greek, and the *Oberrealschulen,* with neither Latin nor Greek. Except in small cities, these are always separate institutions, and the choice of the type of education to be given the boy must be made at the age of nine. The curriculum for each type of school is entirely prescribed. A type of institution also exists known as *Reformschule,* which proposes to give the three types of education in the same institution, basing all on the same work during the first three years, and then branching off into one or the other line. The idea has been favorably received, and the number of institutions carrying it out is growing, but this reform is still experimental and the chief problems of instruction relate to the three standard types of institutions to which the commission confined its work exclusively.

The curricula of 1901 distribute the work of the nine years among the different subjects in accordance with the following table, the unit being one hour per week throughout one year.[4]

	Gymnasium.	Realgymnasium.	Oberrealschule.
Religion,	19	19	19
German,	26	28	34
Latin,	68	49	—
Greek,	36	—	—
French,	20	29	47
English,	—	18	25
History,	17	17	18
Geog. (Pol. & Phys.),	9	11	14
Mathematics,	34	42	47
Natural Sciences,	18	29	36
Writing,	4	4	6
Drawing,	8	16	16
Total,	259	262	262

The marked preponderance of the languages will be noted even in the *Oberrealschule.* Classifying geography in the historical group, where the character of the work done would place it, the distribution may be summarized:

Linguistic—Historical,	195	171	157
Mathematics and Nat. Sci.,	52	71	83
Writing and Drawing,	12	20	22
Total,	259	262	262

The commission recognizes the high culture value of the linguistic-historical studies, but asserts an equally high culture value for mathematics and the natural sciences, and in view of the great and growing importance of the second group of subjects in the culture of our times, it denies the necessity that *every* type of liberal education should be preponderatingly linguistic. In this it voices a sentiment that is widespread and deeply felt among the German people. It may be noted that amidst all this there is not the slightest tendency towards an elective system. The diversities of human aptitudes are recognized, and the commission urges that there are types of minds and careers in life whose needs would be met best by a cur-

[4] For more detailed information concerning the German schools see:

Russell, 'German Higher Schools,' New York, 1898 (Longmans, Green & Co.).

Young, 'Teaching of Mathematics in Prussia,' New York, 1900 (Longmans, Green & Co.).

Bolton, 'German Higher Schools,' New York, 1902 (D. Appleton & Co.).

riculum laying more stress on mathematics and the natural sciences than any now in force, but no one seems to have suggested that it might be best to turn over to each boy the task of making his own curriculum. The attitude of mind on which elective systems are fundamentally based is quite foreign to the German temperament.

Passing to the detailed reports, the commission does not ask for an increase in the time devoted to mathematics, but recommends that still further changes be made in the same spirit as those introduced in the official curricula of 1901. While recognizing the formal value of mathematics, the commission believes that some of its more remote and technical phases may be dispensed with and the time thus gained utilized in awakening and developing the ability to regard and interpret mathematically the processes of nature and the occurrences of human relationships. The most important office of the instruction in mathematics is to strengthen the power of space intuition and to train to the habit of functional thinking. Logical training will not suffer if mathematical instruction be given this trend, but will even gain.

A detailed curriculum is proposed embodying the ideas held by the commission. As compared with the curriculum of 1901 now in force, the proposed curriculum cuts down somewhat the more complex calculations and defers to later periods the more abstract topics and methods; on the other hand, it introduces concrete geometry a year earlier (at the age of ten instead of eleven), demands constant use of drawing and measuring, utilizes graphic methods throughout, brings the idea of functionality and of functional variation into the foreground early (at the age of twelve), and utilizes it freely thereafter, introduces the idea of coordinates, of plotting linear expressions and the graphic solution of linear equations at the age of thirteen (four years earlier than in the curriculum of 1901), permits the introduction of the idea of the derivative and of the integral in the next to last year of the course (age seventeen), and lays marked stress on the application of mathematics as widely as possible. A threefold final goal for the mathematical work as brought to a close in the last year is set up:

1. A scientific survey of the organization of the mathematical material treated in the school.

2. A certain power of mathematical perception and its use in the treatment of problems.

3. Finally and above all, insight into the importance of mathematics for the exact cognition of nature.

The reports on the natural sciences call for more time in these subjects even in the classical schools, at least while, as at present, these schools far outnumber the others, and consequently their graduates in all influential walks of life furnish the great majority of those taking the lead. The commission calls for three hours weekly throughout five years in physics, two hours weekly for four years in chemistry and two hours weekly for nine years in the biologic sciences (and geology).

The report on physics sets up three fundamental principles:

1. Physics is not to be taught as a mathematical science but as a natural science.

2. Physics is to be taught so that it may serve as a type of the manner in which knowledge is attained throughout the domain of the experimental sciences.

3. Suitably planned exercises in observation and experimentation by the pupil himself are necessary.

Specimen courses in physics, in chemistry with mineralogy, in zoology with anthropology, in botany and in geology are given. Detailed discussion of these courses and the recommendations that accompany

them would be undertaken more appropriately and carried through more effectively by specialists in these subjects, so that this mention is allowed to suffice for the present report.

The commission also discussed the question of geography, political and physical, and was of opinion that conditions are not yet ripe for the union of geography with the natural sciences, but that, nevertheless, the bases of geography in mathematics and the natural sciences should be taken up in connection with the instruction in these subjects in the higher schools.

It is apparent from the above sketch that a movement of the first magnitude is in progress in Germany for the fuller recognition of the value of mathematics and the natural sciences, on the one hand, and for the reorganization within these subjects of the subject matter taught and the method of instruction, on the other, so as to adapt the work more fully both to needs and capacity of the pupil and to the demands of the times. The writer does not presume to classify the movement or estimate its import in any but his own subject; in mathematics, however, the movement is certainly of international significance. It is one in spirit and aim with the movements for the improvement of the teaching of mathematics in France, in England and in the United States, and while the Prussian problems surely differ in detail from those of other nations, the underlying principles are the same. Our American conditions are vastly different from those which the commission could presuppose, and consequently there could be no thought that the commission's results as such would be available in America, still the consideration of the fundamental principles underlying this thoughtful report of some of Germany's most eminent scientists can not fail to lead the American reader to ponder the same fundamental questions as modified by our environment, and perhaps to stimulate him to evolve some proposal looking towards the accomplishment here of the same end—as sorely needed here as in Germany—the better adaptation of the instruction to the needs and capacity of the pupil and to the spirit and requirements of our twentieth-century civilization.

J. W. A. YOUNG.
THE UNIVERSITY OF CHICAGO,
November 24, 1905.

SCIENTIFIC BOOKS.

Strandliniens Beliggenhed under Stenalderen I Det Sydøstlige Norge. Af W. C. BRØGGER. Med Tysk Resumé, 11 Plancher, 2 Karter og 9 Figurer i Texten. Norges Geologiske Undersøgelse, No. 41. Kristiania, i Kommission Hos H. Aschehoug & Co. 1905.

The first step in the establishment of a relative chronology for prehistoric times was taken by a Dane, C. J. Thomsen, of Copenhagen, seventy years ago. Much of the subsequent progress along this line has been due to Scandinavians. Professor Brøgger's work on the position of raised beaches in southeastern Norway during the stone and bronze ages is of such a character as to indicate that northern investigators are still among the leaders in the kind of research that tends to render our knowledge of prehistoric archeology more accurate.

That the climate of the kitchen-midden period (first stone age in the north) in Denmark was warmer than at present, is now well known. It has also been established by recent investigations in both Denmark and Sweden that the age of the kitchen middens of southern Scandinavia corresponds to the period of maximum postglacial submergence.

A series of curves are plotted on a map so as to pass through isochronal raised beaches. The general course of these curves through southern Norway, southwestern Sweden and all of Denmark is from northwest to southeast. They show the postglacial submergence to have been greatest around Christiania, where the raised beaches marking the maxi-